Science Connection

KENTUCKY DEPARTMENT OF EDUCATION

A Collaborative Resource for Teachers

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In This Issue

Editor's Note *by Christine Duke*

"What we do, if we are successful, is to stir interest in the matter at hand, awaken enthusiasm for it, arouse a curiosity, kindle a feeling, fire up the imagination." -Julius Suer Miller

Spring certainly has a way of rejuvenating spirits and awakening senses. From plants sprouting through the freshly turned up soil, colorful fragrant flowers blossoming on the side of the road, to robins sitting on their nests through the rain; all these things can lead to students wondering "what changed?" and "why?" I hope that both you and your students feel rejuvenated by the wonders of springtime and that curiosity flourishes.

This edition of the Science Connection presents you with several different science topics intended to peek your interest and provide you with deeper understandings of the connections between all of the content areas. I would like to extend a special thank you to the busy professionals who took on this month's NGSS topics. Your dedication to science education and the students of Kentucky is commendable. KUDOS!

Speaking of curiosity and enthusiasm, many of you have questioned "who is the new KDE science consultant?" It is with excitement that I introduce you to Rae McEntyre. Rae is not a stranger to KDE. She has worn many hats and still does. Besides providing guidance and support in science, she also serves as the assessment liaison.

Rae has 30 years of experience in education, starting as a Biology teacher in the Kingdom of Lesotho as a Peace Corps volunteer. She spent eight years with the Peace Corp before returning to the United States. She then earned her certification in secondary science education to later teach in Knox County, Gallatin County and Grant County before arriving at KDE as a High School Science Consultant. With degrees in both Biology and Geoscience, she has taught both the biological and earth sciences at the high school level. Rae has also had the opportunity to work with NASA Education and Public Outreach for high-energy space missions such as Swift and Fermi. In her spare time, Rae enjoys—you guessed it—being outdoors and observing nature. You can reach Rae at rae.mcentyre@education.ky.gov. Welcome Rae!

Tape charge: Acting at a distance

ELEMENTARY

Dr. Martin Brock
Chemistry, Eastern Kentucky University

Children are introduced as early as kindergarten to key ideas of forces through pushing and pulling. What is not so clear to them is the idea that forces do not need to involve direct physical contact to exert a visible effect. Electrical charge shows this "action at a distance" and simple observations may lead to significant understanding of its properties.

Students of all ages have multiple misconceptions about charge (some of which are addressed in the activity described in the box below). Another misconception equates

Continued on Page 2

NEXT GENERATION SCIENCE STANDARDS

Practice
Engaging in Arguments from Evidence

DCI
PS2: Motion and Stability: Forces and Interactions

Crosscutting Concept
Stability and Change

Continued from Page 1

electrical charge to magnetism. While this activity is exclusively about charge, it is expected that an exploration of magnetism would occur at about the same time. Comparing head-to-head the different and similar properties of these two very important forces should lead students to a more robust sense that they are in fact different forces. Pay special attention to the following differences with your students:

- Magnets require only certain materials such as iron; charge may be found on many different materials
- Magnets have two poles, N and S; an object may have only one charge type
- Magnets and charged objects do not generally interact with each other. Specifically N or S do not have different responses to + and – charges.

Students should be encouraged to write and discuss their observations. An important component of this lesson is to use their observations to formulate some ideas about charge: That there are only two kinds of charge, that charge does not require direct contact for a force to be acting, and that the greater distance between charges reduces the effect. Using their evidence to argue these points is a critical part of standards, but also is consistent with best science practices as well as good teaching. As a teacher, you should probe these concepts with each student after they make their basic observations.

To do the activity with your 3rd- or 6- grade students, you will need plenty of Scotch Magic Tape, balloons (blown up tightly - 12 inch work best), and 18 inch lengths of wooden dowels, suspended about a foot above the bench-top, perhaps using a ring stand and clamp.

You should show your kids how to set up the tape: It should be about 10-12 inches long. For ease in handling, fold about inch of each end over to form “handles,” that is, portions of tape that are no longer sticky. The tape should be pressed tightly, sticky side down, into a smooth surface such as a table top. Some surfaces work better than others (no metal), so try around your classroom first. It works better if you rub the tape onto the surface with the back of your fingernail.

Also, this activity will not work well if the air is at all humid! Holding the tape by one of the handles and with a sudden jerk, rip it off the table and away from the body (your body can transfer charge away from the tapes) and hang it from the wooden dowel. Note the tape should not otherwise be touched. Students will also be making B (bottom) and T (top) pairs of tapes.

Make tapes as before, but tightly press a T tape on top of a B tape. Pull them off the surface together, and then pull them apart carefully, and again away from the body.

The activity also uses a charged balloon. The designation of “positive” for the balloon is completely arbitrary, and can be used to discuss how names for things (*north* and *south* for the poles of a magnet, and *positive* and *negative* for charge) can be pretty random and have no meaningful significance.

Acknowledgement: The author would like to thank Dr. John Christopher, retired from the Physics faculty at the University of Kentucky for suggestions leading to this activity.

Charge and Magnetism are addressed in the Next Generation Science Standards

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Clarification: Examples of cause and effect relationships could include how the distance between objects affects strength of the force

DCI: Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Clarification: Examples of this phenomenon could include … electrically-charged strips of tape

DCI: Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object

Rubbing your feet on a woolen carpet, then giving someone a spark is a consequence of charge. Rubbing a balloon in your hair, then sticking it to the wall, or using it to stand another student’s hair on end is also about charge. Lightening is about charge, electricity is about charge, and we find charge on objects we pull out of the dryer.

Some children were discussing an observation related to charge.

Mattie: The only time I have seen charge is when things are attracted to each other, so there is only one kind of charge interaction: attraction.

Sammy: I think charge is just like magnetism, so there must be two types of charge interaction.

Olivia: I agree that charge is like magnetism, so it must only work on metal objects.

Jordan: But you don’t have to touch something for magnetism to work, but something must be rubbed in order for charge to work, so it must be different.

What do your experiences say about charge? Are these kids on the right track or not?

A. Firmly press a piece of tape firmly onto a smooth surface. Do not touch the tape except by its handles! Pull it off the surface and attach by one end to the wooden dowel.

B. Make a second piece of tape in the same way. Slowly bring the second tape toward the first. Describe your observations.

How does the distance between the tapes affect the interaction between them?

C. Make several of these tapes and test each against all others. Are there consistent patterns of interactions?

D. Next, make two tapes: press one tape onto the table and write a “B” (for bottom) on its handle. Then press a second tape directly on top of each B tape and label it “T” (for top). Pull them off together, then separate them and hang onto the dowel. You should make several of these pairs, very possibly hanging the B tapes as far as possible away from the T tapes.

Observe the interactions between:

Two T tapes when they are brought near one another

Two B tapes

One T and one B tape

Observe these interactions also at different distances between tapes.

Make a set of rules that describe the tape behavior you observe. Your rules should state something like:

“ When the type of tape is the same, then … “

and

“When the type of tape is different, then … “

Discuss with others how many types of tape there must be to explain these rules. Provide evidence!

E. Rub a blown-up balloon vigorously but lightly (don’t press hard) over a woolen sweater or in dry hair. Hold the balloon near the T and B tapes on the dowel.

Continued on Page 3

Continued from Page 2

Compare the interactions of the tapes with the balloon with the interactions between the tapes from before.

Let's just decide to call the balloon "positive." Using your rules about tape behavior, how might you use the balloon's positive property to name the T and B tapes? Which one would be positive? What would you call the other one?

What kinds of materials have you encountered that can have charge? List some of them and provide evidence for this.

KCAS Connections

The musings of a music teacher

ALL

Phil Shepherd, *Manager, Academic Core Branch*

All of my life I've had a deep interest in the science that exists all around us as we make our way in this world. It is so natural, but at times it seems magical the way science weaves in and through everything we do. The sense of excitement about science remains with me to this day, but I have to say, there is one experience with science that changed the way I think about the world.

As a music major in college I decided to take Physics 101 as an elective to fulfill my degree requirements. I knew I would enjoy any science class and this would be a new experience for me. One day the physics professor walked into the room, leaned up against the work station at the front of the classroom and said "Let's talk about sound."

That day lightning struck. Music had been my focus, but this lecture/demonstration expanded my thinking to include the physical powers of sound, transfer of energy, sound waves, waveform, destructive interference, amplitude, frequency and on and on. I began to understand how one can become obsessed with borrowing the power of nature and adding human expression to it to make music. Wow!

Needless to say, that newly discovered enthusiasm carried over into my teaching. For a few years I taught a high school music appreciation course. Students sometimes confessed that they came to the course thinking I would force them to listen to Beethoven until they admitted that they liked it. They also admitted being skeptical when the first thing I played for them was a recording from the top 10 of the week.

Every student readily admitted that they liked music, so my first goal was for us all to discover why. The best way to do that was to discover the underlying power beneath the music we hear every day. We launched into my first unit, "The Science of Sound."

Is there sound in outer space? Day one the students walked into my room to this question on the board. We had to establish a common understanding of how sound is generated and transferred to the human auditory system so it can be heard. (Students often answered, "Yes" to the question and mentioned that they saw it in a movie or on TV.) I started with a simple demonstration. We gathered around a pan of water. I made a small splash in the middle of the pan and asked them what they noticed (waves). I showed them how I could use more or less energy to generate waves and they would change accordingly; larger, smaller, more or less frequently and so on. The waves showed a transfer of energy from my muscular movements into the water. Then I asked them if they ever heard of sound waves.

Step two was to determine what sound waves are and what causes them. To help with this I brought several tuning forks of different sizes to class and let the students experiment in small groups. They were to generate sounds and then determine what was happening based on what they were hearing. After a short amount of time we were able to determine that when we struck the tuning fork it vibrated and those vibrations created sound waves that were carried through air causing our ear drums to vibrate, which enabled us to hear distinct frequencies (pitches) based on the size of the pitch fork. So now we understood that some kind of energy was expended to cause vibrations, which in turn are transferred though the medium of air to our ears, and that this represented a transfer of energy. Is there sound in outer space? Not unless there is a medium to carry the sound waves to our ears.

Now the time was opportune for the introduction of musical instruments. I started with a favorite old Disney cartoon titled: Toot, Whistle, Plunk, and Boom. The cartoon demonstrates in a very entertaining way how woodwind, brass, string, and percussion instruments generate and resonate sound. After viewing the cartoon I had some of my band students demonstrate on their own instruments. We had a set of instruments on hand for the class to try as well, including a set of timpani (also known as kettle drums).

When I asked if anyone noticed some similarities between

Continued on Page 4

Continued from Page 3

the pitch forks and the musical instruments I usually got a response that the difference in the size of the instrument made a difference in the frequency or pitch of the notes. That allowed us to talk more about how resonators (size/length) impacted the sound we hear.

We followed this with a day to experiment with an oscilloscope. Now it was time to see a visual representation of what they were hearing. Musical instruments were used to generate sounds and students could observe differences in frequency (pitch), loudness and softness of sound (amplitude), and now the specific quality of sound (timbre or wave form). This helped us to understand how all those factors could be considered in the creation of organized expressive sound, otherwise known as music.

Now we converted what we knew scientifically into art. Students were assigned to create their own acoustical musical instruments, which they would demonstrate for the class. They were to include examples of what they learned about sound in their short demonstrations:

- How the sound was generated and resonated.
- How they could change frequency (pitch).
- How they could change the amplitude (equated with dynamics or volume in music).
- What characteristic(s) makes for the unique sound (timbre/wave form) of their instrument?

The culminating activity involved assigning students to groups to create a music composition utilizing all their instruments, and to perform that composition for the class. They were required to add expressiveness to their compositions and to determine how they could effectively do so. We took all that we knew about sound and applied it to making music. I'll never forget all the fun that we had learning

Wonder and curiosity

PRESCHOOL - K

Anne Rooney French, *PhD, School Readiness Branch*

The Kentucky Early Learning Leadership Networks (ELLN) working with preschool and kindergarten teachers across the commonwealth focused on science during the two meetings in the spring of 2014. The initial work was looking at the connections between the Kentucky Early Childhood Science Standards and the NGSS Kindergarten standards. One of the key ideas regarding the early childhood standards is that they meet the cross cutting concepts through scientific thinking.

There is only one Early Childhood Science Standard: Demonstrates scientific ways of thinking and working (with wonder and curiosity)

The benchmarks are:

Explores features of environment through manipulation

Asks simple scientific questions that can be answered with exploration

Uses a variety of tools to explore the environment

Collects, describes, and records information through a variety of means, and

Makes and verifies predictions based on past experiences.

It is apparent that the Kentucky early childhood standards provide a continuum of scientific thinking that helps children enter kindergarten with a curiosity about the world around them. By starting early in the preschool years, children will develop a sense of wonder and with the help of caring teachers and parents, they will be able to foster growth in the areas of asking questions, exploring the environment, collecting and recording data as well as making and verifying predictions. These are all skills that children use throughout their years as students.

One of the major focus areas in introducing the science standards is rigor. Rigor requires students to construct meaning and to acquire understanding. Another component of rigor is to help students organize concepts and make connections. Through learning information students are asked to develop thinking skills. These thinking skills can be developed in preschool and in kindergarten programs. Rigor helps students to constantly stretch beyond their current abilities to develop new ways of thinking and understanding. Additionally, rigorous instruction teaches students to use or adapt what they have learned to solve real-world problems in novel ways (Mindsteps.inc). During the ELLN professional learning process, kindergarten and preschool teachers were encouraged to create open-ended questions for units and experiences that are already part of their curriculum. We are moving away from asking questions of which there is only one correct answer. The new way of thinking is to encourage curiosity and wonder.

A website shared during one of the ELLN sessions is Wonderopolis, http://wonderopolis.org/ Teachers can sign up to receive a Wonder of the Day, and each day a new wonder is delivered through e-mail. If you or a child has a question, it can be searched through the website and you can even pose a questions that has never been asked before!

With early childhood and the NGSS standards, intentionality is a key component.

The teachers who were involved with the ELLN program are using more of the project approach in their curriculum. They are also helping the students to see themselves as scientists.

Using math to support argument in the engineering design process

ELEMENTARY/MIDDLE SCHOOL

Jessica Addison, *Instructional Specialist for WKEC*

"Science is a way of thinking." – Carl Sagan

Can't you hear a student now: "Excuse me, Mr. Sagan, I think you have it wrong! Science is simply a long list of rules, laws and properties."

How can we help students see science as a way of wondering, asking, seeking and testing in order to explain and predict? As a vehicle to find solutions to problems facing humankind? To preserve the natural engineering spirit of students, students need opportunities to engage in the engineering design process to solve human challenges. A Framework for K-12 Science Education states: "[t]he actual doing of science or engineering can pique students' curiosity, capture their interest, and motivate their continued study."

While an engineer's work is not limited to designing solutions, "… from a teaching and learning point of view, it is the iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices" (FfK-12Science). The iterative process requires the problem or need to be clearly defined, including constraints, the development of possible solutions, and finally the comparison and improvement of the solution(s). While engaging in the engineering design process students employ a variety of engineering practices and apply scientific understanding.

One of the central practices utilized by engineers is engaging in argument from evidence. When early in the design process, initial ideas might be compared by arguing for or against certain design elements to best meet the constraints and criteria. Later on, solutions must be evaluated and compared. Data collected during this step may be used as evidence to support modifications to the design, acceptance of the design, or a call for additional testing. Student engineers might use data as simple as a line plot in 2nd grade or a linear cost-analysis in middle school or a complex trade-off matrix in high school. Being familiar with the expectations outlined in the Common Core Mathematics Standards, especially in Measurement and Data, Functions, and Statistics and Probability domains, will enable teachers to extend and support grade appropriate data use and interpretation in science and engineering.

In grades K-5, the CCSS for Mathematics requires students learn to represent and interpret data. If designing a solution to make an object move faster, the students might collect simple speed data (clicks on the metronome, claps, etc.) per solution.

This may range from tally marks of data in kindergarten, to "draw[ing] a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories" (CCSS 2.MD.10) in 2nd grade. By the end of 5th grade, students should be able to organize data involving fractional values on a line plot, a skill that might be handy when measuring liquid volumes in a beaker, distance traveled to the nearest ¼ inch, mass of an object.

To meet the demand of Engaging in Argument from Evidence, K-2 students will "make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence," and then in grades 3-5, "use the evidence to show how it meets the criteria and restraints of the problem," all evidence represented in their data (NGSS, Appendix F).

Strategic questioning by the teacher will support students in their journey to use the data accurately. "If it moved for three claps when we used the first solution, and five claps for the second solution, which one moved faster? How much faster? How do you know? What do these marks tell us?

Why it so important to include the scale on our graph? How else might we draw our bar graph to tell the story? How does this data tell us what worked and what we might need to change? By modeling the thinking students eventually need to adopt, the teacher can move them to using the data to continue the engineering process.

Middle and high school students will make use of their developing understanding of Statistics, Probability and Functions in order to evaluate design solutions and advocate for adjustments. In 8th grade, students can "[c]onstruct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities" (CCSS 8.SP.1).

They might use this skill to construct a graph to record and predict the speed of a moving object. In high school, a student will benefit from the opportunity to apply their abstract understanding of linear, quadratic, exponential and even periodic functions to model the relationship between two variables. In describing the path of a stomp rocket, for example, the students connect quadratic functions with their developing understanding of velocity and acceleration.

The few examples mentioned here merely scratch the surface of opportunities for students to relate ideas in science and engineering to key ideas in mathematics.

These connections support their use of data as evidence in the engineering design process. Evidence they will need to compare, evaluate and optimize their solutions.

By engaging students in thinking this way, we are preparing them to think like engineers who respond to the demands and needs of humankind and, ultimately, to see science and engineering as a way of thinking.

Engaging in arguments from evidence: opportunities in environmental education

ALL

Elizabeth Schmitz, *Executive Director*
Kentucky Environmental Education Council

Environmental education provides many opportunities for students to engage in arguments from evidence. The environment can be a controversial topic, and environmental education provides many opportunities for students to take a position and use evidence to support it. Some examples include land use decisions (e.g. where to locate a landfill or pipeline), energy policy, and natural resource management. Therefore, environmental education topics often integrate science, social studies, and language arts.

Many teachers find that allowing students to explore these topics engages them in learning in new and exciting ways, helps them become more empathetic and open-minded by exploring different points of view, and allows them to become more comfortable with researching challenging topics.

Weather and climate provide one such example of a theme that can carry through from elementary through high school ages. Using the local environment as a context for learning allows students to engage in direct observation. Direct observation and data collection provide a platform for students to interpret what they have seen. At young ages, it is important for teachers to help their students tie their claims directly to evidence gleaned through observation and/or experimentation.

Young children can collect and report on weather data daily or weekly throughout the school year. Using the data gleaned from tracking precipitation and other weather related phenomena, children may begin to use claims-based reasoning to discuss weather, weather-related patterns, and climate. As students get older, they may integrate weather and climate data from online sources and use those to support or refute claims.

Some scientific concepts, such as climate change, may be considered controversial. In fact, contrasting opinions and claims are common when it comes to climate change. By exploring various claims, data, and reasons evident in various facets of the discussion on climate change, students can critically examine scientific arguments and present counterarguments where appropriate.

By examining the claims of scientists or the media, and looking for data that supports or denies these claims, students can investigate data sources and form their own reasoned ideas.

There are a number of excellent resources available to support teaching about climate change, energy or other sometimes controversial topics:

- Climate Literacy and Energy Awareness Network (CLEAN) at cleanet.org, but more specifically via their Educational Resources tab: http://cleanet.org/clean/educational_resources/index.html Use the search bar at the top of the page to find activities specific to grade level, climate literacy principle, energy literacy principle, or topic, including: the climate system, causes of climate change, measuring and modeling climate change, the nature of climate science, energy use. Search the Climate Literacy Principle "Humans Affect Climate" to find 88 activities and resources that can be selected by grade level. Or get more specific and look at a subheading under that topic – Human activities have increased GHG levels and altered climate patterns – for access to 34 resources and activities, including CO_2 data from Mauna Loa, satellite images, and a Climate Wizard that allows students to choose a state or country and assess how climate has changed over time and project what future changes are predicted to occur.
- The National Oceanic and Atmospheric Administration offers education resources for teachers that focus on weather and weather related phenomena: http://www.education.noaa.gov/tweather.html
- Webinars are available to help provide teachers with resources to help students discover, research, and discuss wildlife conservation (these may have bias): http://www.wcs.org/teachers/teacherpd/webinars.aspx
- High school teachers may be interested in a Media Literacy and Sustainability Education Webinar, scheduled for Thursday, October 2, 2014, from 7:30 – 8:30 EST. How to use media decoding to invite students into safe collective reflection on the strong emotions that often rise in response to the challenges of sustainability. High school and college educators and teachers-in-training will learn pedagogical techniques and curriculum materials that can help students to engage in critical thinking and emotional honesty about the complex environmental, economic and social systems that underlie sustainability.https://www.eventbrite.ca/e/media-literacy-and-sustainability-education-tickets-11060118111
- More webinars and other local, state, national, and international professional development and environmental education resources may be found at http://eeinkentucky.org.

SCIENCE CONNECTION *Continues on Page 8*

Engaging in argument in the elementary classroom

ELEMENTARY

Ingrid Weiland, *Assistant Professor of Elementary Science Education, University of Louisville*

How do we engage our elementary students in meaningful discussion about scientific data? The seventh Science and Engineering Practice states that our students should engage in argument from evidence. While much of the elementary science curriculum (e.g. FOSS) commonly used lends itself to doing the eight Science and Engineering Practices, oftentimes the practice of argumentation is omitted in the elementary classroom. In fact, some science education researchers have suggested that argumentation is not developmentally appropriate for elementary students. However, there are many resources available that have examined how to teach argumentation at the elementary level (see Table 1.). What needs to be in place to promote an atmosphere and curriculum that allows children to challenge each other's explanations and reasoning? Articles written on scientific argumentation in the elementary classroom note the following keys aspects:

- Distinguishing between data and evidence
  - Data is the quantitative and qualitative observations that are recorded either by the students or provided to the students. This data is then analyzed for patterns. It is these patterns that serve as the evidence to support scientific/engineering claims
- Providing a variety of data so that students can formulate various explanations
  - It is difficult to engage students in scientific argumentation and to analyze claims, evidence, and reasoning if students are all examining the same data sets. Differing data sets, that result in varied explanations, are critical for engaging in analysis of the reasoning process.
- Fostering an atmosphere of respect
  - It takes time to develop an environment in the classroom that allows students to respectfully challenge one another. One way to foster this environment is to model how to challenge ideas in a respectful way, and to offer children opportunities to challenge the teacher.
- Providing sentence starters for students to challenge each other's notions
  - Sentence starters can scaffold students' thinking and oral discussion. These sentence starters could include:
    - * I agree with ___ because___
    - * I wonder if that is accurate. Have you thought about ___?
    - * I think it is important to pay attention to ____.

*Table 1. Some Resources for Teaching Argumentation in the Elementary School**

Fulwiler, B. (2011). Writing in science in action: Strategies, tools, and classroom video. Portsmouth, NH: Heinemann.
Hand, B., & Norton-Meier, L. (Eds.) (2011). Voices from the classroom: Elementary teachers' experiences with argument-based inquiry. Rotterdam, The Netherlands: Sense Publishing.
Norton-Meier, L., Hand, B., Hockenberry, L. & Wise, K. (2008). Questions, claims, and evidence. Portsmouth, NH: Heinemann.
Reiser, B., Berland, L., Kenyon, L. (2012). Engaging students in the scientific practices of explanation and argumentation. Science & Children, 49(8), 8-13.
Zeidler, D., & Kahn, S. (2014). It's debatable! Using socioscientific issues to develop scientific literacy K-12. Arlington, VA: NSTA Press.
Zembal-Saul, C., McNeill, K., & Hersherberger, K. (2012). What's your evidence? Engaging K-5 children in constructing explanations in science. New York, NY: Pearson Allyn & Bacon.
Science & Children, themed issue on argumentation. (July 2013). Volume 50, Number 9

 Continues on Page 8

Have you ever wondered what sound looks like?

ALL

Leanne Burbank

When light passes between areas of different air density, it bends. You've probably noticed the way distant pavement seems to shimmer on a hot day, or the way stars appear to twinkle. You're seeing light that has been distorted as it passes through varying air densities, which are in turn created by varying temperatures and pressures.

A 19th Century photography technique called the Schlieren Flow Visualization visually capture these changes in density and allows scientists and engineers to see things that are normally invisible.

For a video that can be used in classrooms illustrating the Schlieren Flow Visualization go to the National Public Radio (NPR) article What Does Sound Look Like? at http://www.npr.org/2014/04/09/300563606/what-does-sound-look-like.

A firecracker exploding using a high-speed camera shows the sound waves emanating from the source

Be in the Know

EQuIP Rubric for Science Released

The [Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric for Lessons & Units: Science]() was released in April.

The rubric provides criteria by which to measure the alignment and overall quality of lessons and units with respect to the Next Generation Science Standards (NGSS). The purpose of the rubric is to (1) provide constructive criterion-based feedback to developers; (2) review existing instructional materials to determine what revisions are needed; and (3) identify exemplars/models for teachers› use within and across states.

This document was developed in response to the recognition among educators that while curriculum and instruction will need to shift with the adoption of the NGSS, there is currently a lack of high-quality, NGSS-aligned materials.

The power of the rubric is in the feedback it provides curriculum developers and in the productive conversations educators can have while evaluating materials.

For curriculum developers, the rubric and review process provide evidence on the quality and alignment of a lesson

Continued on Page 9

Continued from Page 8

or unit to the NGSS. Additionally, the rubric and review process generate feedback on how materials can be further improved and more closely aligned to the NGSS.

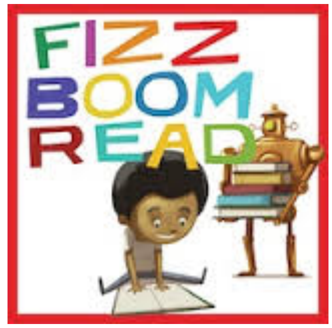
As more NGSS-aligned lessons and units are developed, this rubric may change to meet the evolving needs of supporting both educators in evaluating materials and developers in the modification and creation of materials.

For example, rubric scoring guides will eventually be added.

Additional support materials will also be developed to complement the use of this rubric, such as a professional development guide, a criterion discussion guide, and publishers› criteria that will be more focused on textbooks and comprehensive curricula.

Kentucky Summer Reading Program

Submitted by **Kathy Mansfield**, *KDE Library Media/Textbooks Consultant*



The Summer Reading themes for most of the state's public libraries this year are "Fizz, Boom, Read!" (elementary) and "Spark a Reaction" (teens), which tie in great with Kentucky's new science standards. Encourage your students to sign up for the free Summer Reading Program at your local public library where they will have fun with science experiments, guest speakers from science careers, wildlife encounters, and of course, lots of books related to science! More information about Summer Reading opportunities is available from your school library media specialist or from Kathy Mansfield, KDE Library Media/Textbooks Consultant (kathy.mansfield@education.ky.gov).

Assessment

Part 3.

Whole class questioning: Eliciting deep student responses

ALL

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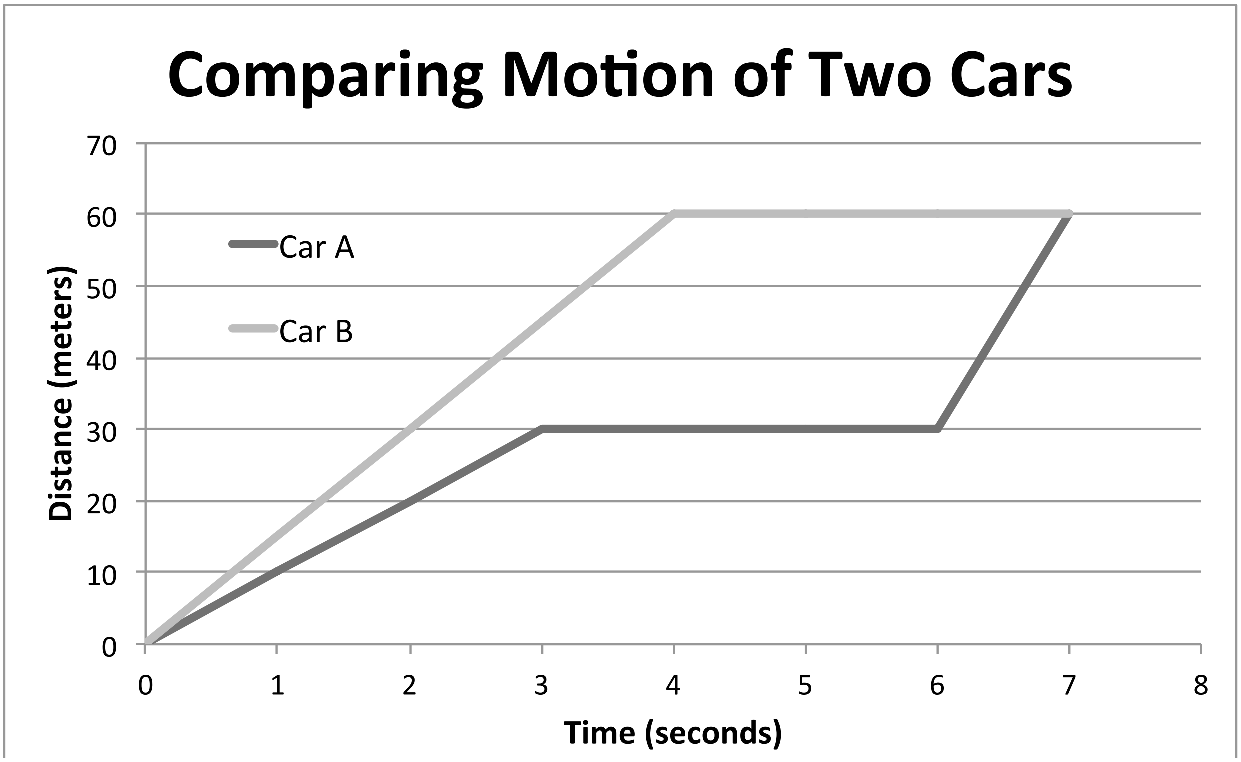
Welcome to the third entry in our series on increasing the effectiveness of whole-class questioning. In this issue, we'll be examining how we learn about what students know based on the amount of information they provide in their responses. Recall from the first entry in this series that formative assessment focuses on how we, the teachers, can learn about what our students understand in order to adapt our instruction accordingly. Last month, we focused on the types of questions that we ask during class discussions in order to find out what students know. Our knowledge of what students are thinking is limited by what the students actually share with us – in the case of whole-class questioning, this means the statements that students make in response to the questions we ask. This month, we'll examine the kinds of student responses that we frequently encounter and discuss some ways to increase the amount of information we can get from those responses, using the NGSS PS2 standard to illustrate several examples.

Many questions can be answered by simple yes-or-no responses, a head shake, "I don't know", or making a choice from several options given by the teacher. While this information can be useful in knowing whether students are on track or following the lesson, it tells us very little about what students know. Consider this episode of a teacher discussing a distance-time graph to compare the speed of two vehicles, Car A and Car B:



Teacher: Look at the graph. Both cars traveled the same distance. Which car traveled faster, Car A or Car B?

Student: Car B.

Is the student guessing, or does the student understand why Car B is traveling faster than Car A? We can't really tell from this exchange.

Similarly, students often respond to our questions by giving single word responses or short phrases. The student may have memorized the correct response, but this does not really tell us whether the student holds a deep understanding of the concept. Consider this question from the same scenario as above:

Teacher: What is Car A doing during the second leg of its journey, between 3 and 6 seconds?

Student: No motion.

Does the student in the last scenario just know that a horizontal line is always "no motion", or does the student understand that the speed of the car is related to the slope of the line on the distance-time graph? If the student has memorized a set response to a question, s/he may be confused when presented with a new graph (such as a velocity-time graph, where a horizontal line above the X axis means the object is traveling at a constant speed). To make sure students have learned the content thoroughly, we need to know that they have made the connection between the representation of motion on a graph and the motion of an object. What might an effective student response look like?

Teacher: Between seconds 6 and 7, Car A is traveling faster than Car B. What is our evidence for this from the graph?

Student: Since the slope of the line for Car A is higher <steeper>, we know it is going faster because speed is the distance traveled over a certain amount of time. On this graph, distance over time is the slope of the line.

So, how can we get this kind of deeper response from our students? You may have already noticed that there is a strong link between the depth of questions we ask and the depth of responses we receive – if we ask yes/no questions, we tend to receive yes/no responses. One important strategy, then, is to increase the quality of our questions as we discussed last month. But sometimes we ask good questions but still get minimal responses from students. Here are some suggestions for eliciting deeper responses from students:

- This last vignette gives an example of "Fact-First Questioning" (Keeley, 2008). By giving students the factual observation first, we reduce the likelihood they will give us simple responses.
    - Practice good "wait time". Rapid responses to questions are wonderful for competing in Jeopardy™, but not very effective at informing the teacher what a student knows! If we want students to construct more detailed responses that show their thinking processes, we have to give them time to carefully consider their responses. Try counting silently to 5 before calling on a student, or use a "Think, Pair, Share" strategy (Keeley, 2008) to prompt students to develop a response prior to verbalizing it in front of the whole class.
    - Train students in your desired responses, perhaps by discussing model responses – but try to refrain

Continued on Page 11

Continued from Page 10

from letting students off the hook by elaborating on their responses yourself. You might have to work explicitly with students to build their skills and confidence with giving thorough, deep responses – but the payoff will be greater knowledge of what your students know – and that's valuable data for us to use to know our students are learning!

References:

Keeley, P.D. (2008). Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning. Thousand Oaks, CA: Corwin Press.

Professional Learning Opportunities

**University of Kentucky STEM Education Department and College of Agriculture, Food and Environment
Present**

2014 SUMMER INSTITUTE for Grade 6-8 Teachers

Project-based Explorations Investigating the Kentucky River Watershed

June 23-25 and July 10 & 11

Session I, June 23, 24, 25

UK & Robinson Forest
Clayhole KY (Breathitt County)

Session II, July 11 & 12
UK & General Butler State Park
Carrollton, KY

Institute Objectives

- Conduct project-based investigations on the Kentucky River Watershed that implement Kentucky Common Core Standards, and Science and Engineering Practices.
- Learn to use GPS and Google Maps as an investigation tool and way to post and access data
- Conduct environmental surveys that lead to making comparisons of land use and water quality across the watershed
- Guide middle school students in planning and implementing watershed investigations to draw conclusions about their own area.
- Using digital technologies to search, use, and communicate scientific ideas.
- Create project-based investigations for your local watershed.

For more information and registration call 859-257-1993 or visit http://enri.ca.uky.edu/outreach/KRWater-

Kentucky Science Center's 2nd level opens 12 new exhibit experiences

A new World We Create, developed specifically to support engineering design and cross-cutting concepts of the NGSS, challenge both creativity and problem-solving skills. Students of all ages can work in teams to design a complex pipeline at Pathways that illustrate gravity, kinetic and potential energy; experiment with center of mass and balance at Last Top Standing; imagine, design and create the ultimate 3D structure at Skyline; discover buoyancy and aerodynamics at the Windtubes and Bernoulli Blower; deduce that accurate trajectory sends a rocket through the Launch Window; and analyze the properties of Light, Lasers, and Electromagnetism.

Students can participate actively in structures and properties of matter in Nano.

Funded by the NSF and developed by Boston's Museum of Science, Nano explores the unseen world of nanotechnology and explores the structure and properties of matter at the nanoscale.

In addition, environment graphics surround the space that promote a greater understanding of what it means to practice the problem-solving that is inherent to engineering design utilizing cross-cutting concepts, while extension activities promote analysis of cause, effect, independent and dependent variables.

NGSS: MS-ETS1-1 & 1-2; 3-5ETS1-2 &1-3; PS1-1; PS1-2; PS1-3; PS2-1; PS4-1; STS1-2

New traveling van program -- Ion Jones & the Lost Castle of Chemistry

Discover the hidden treasures of chemistry in this action-packed, heart-pounding adventure! Team up with chemistry adventurer Ion Jones on a global quest to collect the elements. Journey to rain forests, deserts, glaciers, ancient temples, and prehistoric carbon deposits, and learn how we use chemistry in industry, biology, technology, and the environment.

Is it a far stretch from the Pillar of Polymers? Can we escape the Cavern of Catalysts in time? By the time your students reach the Castle, they will have explored states of matter and observed chemistry in action—from chlorine to combustion. This interactive, multimedia chemistry demonstration is downright explosive!

Ion Jones is the 2nd offsite program traveling throughout Kentucky. It joins Captain Current vs the Electricity Vampires, an interactive assembly and demonstration exploring concepts of energy production and conservation, which ended a successful second year run serving nearly 1,800 students throughout the state.

NGSS: PS1-1; PS1-2; PS1-3;

Kentucky Science Center's teacher professional learning goes virtual

Beginning this fall, the Science Center will beam educator workshops directly into your classroom. Workshops all focus on practices and methods to integrate NGSS engineering practices into your science curriculum, even those subjects that don't appear to lend themselves to engineering. Exact dates are being determined, but the tentative schedule /topics are:

Engineering practices in Biology/Environment - August 2014
Engineering practices in Earth Science – October 2014
Engineering practices in Energy, Force & Motion – February 2015

To receive a program at your site, your classroom or school should be equipped with some kind of telecommunication – polycom or similar. Each class will be approximately 90 minutes in length and participants will receive pre-class materials. Cost is $25 per person.

Summer Modeling Workshop

Western Kentucky University
Dates: July 7 -25
Content: mechanics
Leaders: Aaron Debbink, Ben Buehler
Mix of credit and non-credit participants, contingent on sufficient enrollment
Tuition: $1470 for 3 graduate credits; or $750 for continuing education units only (CEUs)
Contact Dr. Richard Gelderman for details.

A Modeling Workshop in high school physics, chemistry, biology, and junior high physical science will be offered this summer at Western Kentucky University. Modeling Instruction is designated as an Exemplary K-12 science program by the U.S. Department of Education. The Modeling Workshop thoroughly addresses most aspects of high school science teaching, including integration of teaching methods with course content. It will incorporate up-to-date results of physics and science education research, best high school curriculum materials, use of technology, and experience in collaborative learning and guidance.

For more information go to http://modelinginstruction.org/teachers/workshops and for

Workshop descriptions at http://www.phystec.org/pd/?set=Modeling

NGSS Short Courses for Teachers

One-day short courses for elementary, middle, and high school teachers focused on strengthening content understanding, developing and using models, and using mathematics and computational thinking. Teachers will leave with a deeper understanding of the NGSS, both content and practices, along with sample activities that can be used with students.

$125 per session

Date	Topic	Grade Levels
June 16	Light	1 and 4
June 23	Force and Motion	K and 3
June 30	Properties of Matter	2 and 5
July 21	Developing and Using Models	6 through 8
July 25	Using Mathematics and Computational Thinking	9 through 12

Complete details on each course here: http://www.rsvpbook.com/ngssshortcourses
Find all of PIMSER's professional development opportunities at www.uky.edu/p12mathscience

The Kentucky Writing Project and the Kentucky Department of Education present two Summer 2014 workshops on Science Literacy through Science Journalism

July 7, 8, 9 8:30-3:30 Eastern / Louisville, KY
July 22, 23, 24 8:30-3:30 Eastern / Ashland, KY
18 hrs. PD credit
What: This three-day workshop will support you in engaging students in meeting the new Common Core Standards for research through the SciJourn process (www.scijourn.org). Based on a four-year NSF-funded research project demonstrating that teaching science journalism using reliable data sources and science-specific writing standards improves students' understanding of and literate engagement in science. Participants are invited to join the KWP SciJourn Network to receive follow-up support and share their students' experiences with like-minded teachers.

Who: Middle and High School science teachers and language arts teachers interested in authentic writing experiences for their students. Facilitated by the Kentucky Writing Project SciJourn Leadership Team.

Cost: $250 per person (Early Bird price, $200 by June 1). Registration includes text: Front Page Science: Engaging Teens in Science Literacy (NSTA Press) For more information please contact Marsha Buerger, KWP SciJourn Director and Co-Director of the Louisville Writing Project: marsha.buerger@jefferson.kyschools.us, 502-727-6933.

 Continues on Page 14

Collaboration and Connections:

The Science Connections Newsletter offers a forum for science professionals across Kentucky to collaborate and share classroom experiences. You are encouraged to share instructional strategies, resources and lessons that you have learned with colleagues across the state. Note that your entries should relate to one, or all, of the topics for the next month as noted below.

Below are the upcoming SCN focus dimensions:

Coming up:	Science and Engineering Practice	Disciplinary Core	Crosscutting Concept
June	Using Mathematics and Computational Thinking	LS3: Heredity: Inheritance and Variation of Traits	Structure and Function
July	Obtaining, Evaluating and Communicating Information	ESS3: Earth and Human Activity	PatternsPlease be advised that the Kentucky Depart-

E-mail your contributions to christine.duke@education.ky.gov.

All submissions are needed by the 25th of the month.

KDE Revised Consolidated Compliance Plan for Non-Discrimination

Please be advised that the Kentucky Department of Education has revised its Consolidated Compliance Plan for Non-Discrimination. The revised plan has been posted on the Legal and Legislative Services page on KDE's website and includes a Discrimination Complaint Form that can be filled out by anyone alleging discrimination against KDE staff and/or KDE program areas.